Available online at www.sciencedirect.com
ScienceDirect
Journal of the Egyptian Society of Cardio-Thoracic Surgery 24 (2016) 65–72
http://www.journals.elsevier.com/journal-of-the-egyptian-society-of-cardio-thoracic-surgery/

Original article

Efficacy of paravertebral block analgesia for post-thoracotomy pain control

Ahmed Labib Dokhan [a], Montaser Elsawy Abd Elaziz [a,*], Khaled Mohammed Gaballah [b]

[a] *Department of Cardiothoracic Surgery, Faculty of Medicine, Menoufia University, Egypt*
[b] *Department of Anaethesia and Intensive Care, Faculty of Medicine, Menoufia University, Egypt*

Received 22 March 2016; revised 25 April 2016; accepted 25 April 2016
Available online 16 June 2016

Abstract

Background: Paravertebral block (PVB) is an effective analgesic technique for post-thoracotomy pain, whereas there is no clear proof on how it can be more effective. We aimed to assess if the pleural integrity has a significant effect on thoracic PVB analgesia.
Methods: Data of patients who underwent thoracotomy and paravertebral catheterization in Menoufia University Hospitals, between November 2010 and December 2014 were retrospectively collected. Patients were classified into two groups; group A, where the parietal pleura was disrupted, and group B, where there was no pleural tear. Pain scores and pulmonary functions were compared between both groups. Also the frequency of PVB analgesia and the need for supplementary drugs taken as well as the use of rescue pain medications were assessed in both groups.
Results: 132 patients were analyzed; group A (n = 68) patients with pleural disruption and group B (n = 64) patients with intact pleural. There was no statistical significant difference regarding age, sex, body mass index, American Society of Anesthesiologists score (ASA), diagnosis, and operative details. Pain scores were significantly lower in group B, where no pleural tear. Pulmonary functions significantly improved among intact pleura group. Significant increases in the frequency of PVB analgesia, supplementary drugs taken in postoperative period and in the use of rescue drugs were observed in patients with pleural disruption. Complications were higher in pleural disruption group.
Conclusion: Preservation of integrity of the parietal pleura is essential for the quality thoracic PVB.

Keywords: Thoracic general subjects; Paravertebral block; Pleural disruption; Post-thoracotomy pain

1. Introduction

Post-thoracotomy pain remains a challenging clinical problem that may be associated with increased morbidity and mortality. Previous studies have found that ineffective pain control may lead to serious pulmonary complications because of insufficient clearance of secretions, mucous plugging, and atelectasis [1].

* Corresponding author. Tel.: +20 1277280480.
E-mail addresses: mnt_swy@yahoo.com, montaserabdelaziz1@gmail.com (M.E. Abd Elaziz).
Peer review under responsibility of The Egyptian Society of Cardio-thoracic Surgery.

http://dx.doi.org/10.1016/j.jescts.2016.04.012

The paravertebral space is a wedge−shaped space that lies to the side of the vertebral column and contains the spinal (intercostal) nerve, the dorsal ramus, the rami communicantes and the sympathetic chain. Application of local anesthetic within the paravertebral space produces unilateral somatic and sympathetic block, which is better for unilateral surgical procedures of the chest and abdomen [2].

Thoracic PVB was originally described by Sabanathan et al. [3], and they subsequently updated this technique by inserting an indwelling extrapleural catheter for infusion of local anesthetic drugs (LA) in the postoperative period. Several studies assessed the analgesic effectiveness of thoracic PVB [4−6]. The use of Seldinger technique for catheter insertion under vision with a trocar passed one space below the thoracotomy wound posteriorly is easy and safe method. To avoid pleural tear, once the catheter tip becomes visible in the extra-pleural space through the thoracotomy wound, the catheter is passed through the trocar and positioned to lie vertically covering two to three intercostal spaces [7,8].

We applied this study to evaluate the effect of keeping the pleural membrane intact on the success of thoracic PVB catheter analgesia.

2. Patients and methods

2.1. Study design

After approval of the study protocol by the Menoufia Ethics Committee, we retrospectively selected patients from a surgical database records in the Cardiothoracic Surgery Department, Menoufia University Hospital, Egypt. All patients had thoracotomy and paravertebral block catheter for different surgical procedures including pulmonary lobectomy for primary lung cancer, lung abscess, or bronchiectasis, and repair of bronchopleural fistula, resection of posterior mediastinal mass, from November 2010 to December 2014.

Exclusion criteria included; patients who were under 18 or over 75 years of age, those with a history of severe cardiac disease, hepatic or renal failure, those with American Society of Anesthesiology class (ASA) IV or higher, those who underwent resection of the pleura or chest wall, those with bleeding tendencies or were receiving anticoagulant therapy, those with a known allergy to local anesthetic agents, those having a neurological disorder, and those receiving opioid therapy for chronic pain treatment.

The surgical approach in all patients was a muscle sparing posterolateral thoracotomy through the 5th intercostal space, usually extending from the midscapular to the anterior axillary line with an incision length of 10−12 cm. At the end of the procedure all patients were extubated.

Patients were classified into two groups, group A ($n = 68$) where there was pleural disruption, and group B ($n = 64$) with intact pleural membrane.

Postoperative pain and pulmonary functions were the primary outcomes, where the frequency of paravertebral block analgesia (PVB), supplementary drugs (paracetamol) and the postoperative complications were the secondary outcomes.

Visual analogue scale (VAS) was used for assessment of postoperative pain degree at one, six, 12, 24, 48, and 72 h. The scale was used from zero (no pain) to 10 (intolerable pain) usually by the cardiothoracic surgery resident or a well-trained nurse. A score >3 indicated pain requiring an analgesic administration in the form of Bupivacaine in the paravertebral catheter as 20 ml Bupivacaine 0.5% in 5 ml increments (Marcain Plain; AstraZeneca, Egypt®) until the VAS for pain score at rest was three or less.

To ensure a good cough effort and excellent physiotherapy, every patient was strongly encouraged to take analgesia without hesitation, if needed, as a supplementary drug in the form of an intravenous infusion of 1 g of paracetamol (Paracetamol, Egyptian European Pharmaceutical Industry, Egypt®) every 8 h in the first 2 days then oral paracetamol during the following 5 days. Every postoperative patient was not allowed to take supplementary drug not <8 h apart, which indicated that the maximum frequency of supplementary drugs use allowed was three times a day. In the case of analgesic failure with paracetamol, meperidine (Pethedin 50 mg), a synthetic opioid, (0.5−1 mg/kg/dose, as bolus subcutaneous or intravenous injection) was given. It was given maximally every 12 h and was used as a rescue medication.

Pulmonary function tests were performed by using a spirometry (Cosmed®). We used forced expiratory volume in first second (FEV1) percentage of the predicted both preoperative and three days postoperative and usually done by a well-trained pulmonologist.

2.2. Technique of intraoperative PVB catheter insertion

Before closure of the thoracotomy, an indwelling extrapleural catheter (Tuohy 18 G; Braun, Melsungen, Germany®) was inserted intraoperatively by the surgeon. The classic surgical method for insertion of extra-pleural catheters is creation of a tunnel lateral to the parietal pleura and placing the catheter as deep as possible in this tunnel. But this method was found to be associated with a significant leak of the local anesthetic into the pleural space resulting in a less effective postoperative pain control. So instead of creating a tunnel into the parietal pleura, we usually use a Seldinger technique of catheter insertion under vision and intraoperatively in our operations. We used a trocar which is passed one space below the thoracotomy wound posteriorly. When its tip was visible in the extra-pleural space through the thoracotomy wound, the catheter was passed through the trocar and positioned to lie vertically covering two to three intercostal spaces. About eight ml of 2.5% Bupvicaine were injected into the catheter to ensure ideal position. Ballooning or tenting of the parietal pleural membrane without significant leakage of the local anesthetic drug into the pleural cavity is a good predictor of correct catheter position. The catheter was fixed against slippage by 3/0 silk sutures. We believe that this method of insertion offers better pain control as the extra-pleural space is closed above the catheter tip allowing no leakage into the pleural cavity and there was coverage of more than one intercostal space in contrary to creating an open tunnel. The PVB catheter was placed to allow the local anesthetic to distribute into two to three intercostal spaces above and below the level of the thoracotomy. Then, following lung re-inflation before chest closure, administration of LA was initiated through the PVB catheter, producing pleural tenting [3,7,8]. We supposed that intact pleura could contain administered LA well within the extrapleural space and pleural tenting was created (Fig. 1), whereas the disrupted pleura hardly made pleural tenting with almost no LA accumulated extrapleurally (Fig. 2). In our study we used the local anesthetic in the form of 20 ml Bupivacaine 0.5% in 5 ml increments.

2.3. Statistical analysis

Continuous variables, such as age were expressed as the mean ± S.D. and compared by unpaired t-test. Categorical variables were expressed by number (n) and frequencies (%). The χ2-test was used to compare the proportions. Statistical analyses were carried out using the Mann−Whitney U-test to analyze pain scores, and Wilcoxon signed rank test to analyze pulmonary functions.

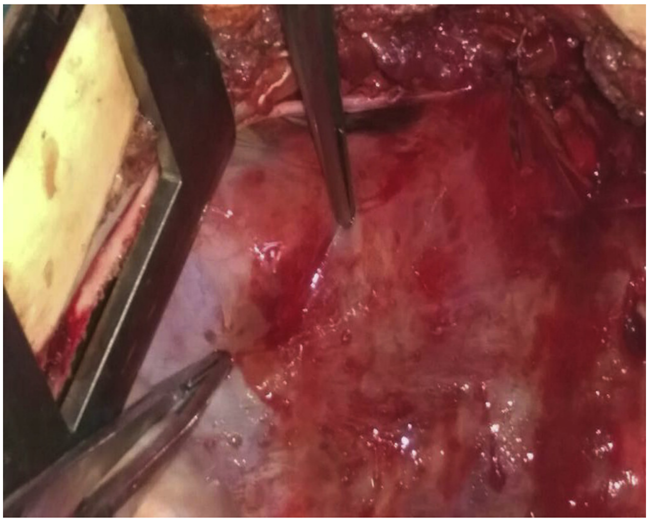

Fig. 1. The PVB catheter lies between 2 forceps with intact pleural membrane.

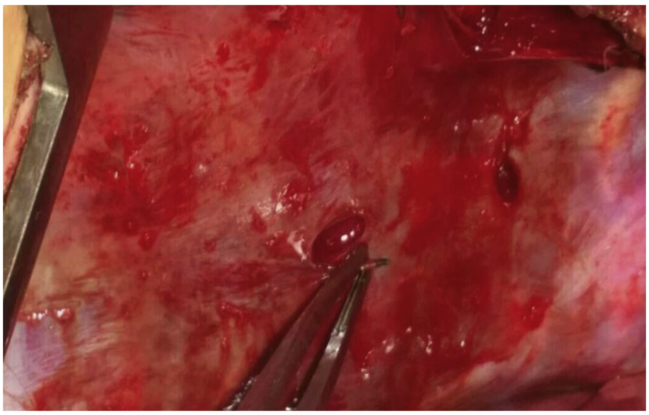

Fig. 2. Paravertebral block catheter in place with its tip seen held with forceps and emerges through the parietal pleural tear.

Comparisons of data were made with the overall α-error set at 0.05 (two-tailed). Analyses were conducted with the SPSS version 20 software (SPSS, IBM, Chicago, IL, USA).

3. Results

132 patients underwent thoracotomy and thoracic PVB analgesia for different surgical procedures. There were no significant differences between both groups with respect to age, gender, body mass index (BMI), ASA score, pathological diagnosis, types of operation, and mean duration of the surgical procedure. There were statistically significant differences between both groups as regards postoperative day of discharge where it was 4.2 day in group A, versus 2.87 day in group B. Also there was significant difference in percentage of patients needed rescue drugs where it was higher in group A (disrupted pleura), Table 1.

There was statistically significant lower mean values of postoperative pain scores in group B than in group A, throughout the first postoperative 24 h, whereas during the second and third postoperative days, VAS for pain scores were lower in group B but without statistical significant difference, Table 2.

Table 3 presented the changes in postoperative FEV1% of predicted value from preoperative one in both groups where it was improved significantly in group B, ($p = 0.03$) and the improvement was not statistically significant in group A ($p = 0.08$).

The need for PVB analgesia with Bupivacaine was significantly lower among patients in group B (with intact pleura) during the first two postoperative days, ($p < 0.001$). The use of supplementary drugs was also significantly lower in group B, during post-operative days 1, 2 (POD-1, 2) where ($p < 0.001$), as in Table 4.

Table 1
Demographic and operative data.

	Group A (n = 68)	Group B (n = 64)	P-value
Age (mean ± SD)[a]	61.3 ± 8.36	58 ± 9	0.93
Sex N (%)[b]			
Male	42 (61.7)	40 (62.5)	0.92
Female	26 (38.3)	24 (37.5)	
BMI(mean ± SD)[a]	20.8 ± 2.8	19.6 ± 2.7	0.7
ASA score N (%)[b]			
II	42 (61.7)	38 (59.4)	0.77
III	26 (38.3)	26 (40.6)	
Diagnosis N (%)[b]			
Lung cancer	13 (19.1)	10 (16.6)	0.46
Lung abscess	20 (29.4)	20 (31.2)	
Bronchiectasis	15 (22)	18 (28)	
Spontaneous pneumothorax	16 (23.5)	14 (21.8)	
Mediastinal Mass	4 (5.9)	2 (3.1)	
Operation N (%)[b]			
Lobectomy	48 (70.6)	48 (75)	0.71
BPF repair	16 (23.5)	14 (21.8)	
Mediastinal mass resection	4 (5.9)	2 (3.1)	
Operative time/min (mean ± SD)[a]	165 ± 23	170 ± 23.8	0.8
POD of discharge (mean ± SD)[a]	4.19 ± 1.54	2.87 ± 1.18	<0.001
Patients needed rescue drug N (%)[b]	16 (23.5)	6 (9.4)	0.029

[a] Student t-test.
[b] Chi-square test, BMI:body mass index, ASA: American Society of Anesthesiologists score, BPF: Bronchopleural fistula, POD:postoperative day.

Table 2
Visual analogue scale for postoperative pain score.

Postoperative hours (mean ± SD)	Group A (n = 68)	Group B (n = 64)	P-value
1 h	4.68 ± 1.26	3.67 ± 1.29	0.001*
6 h	2.8 ± 1.28	2.3 ± 0.79	0.01*
12 h	2.2 ± 0.86	1.3 ± 0.58	0.001*
24 h	2.03 ± 0.77	1.09 ± 0.42	0.001*
48 h	1.04 ± 0.46	0.76 ± 0.25	0.33
72 h	0.75 ± 0.44	0.69 ± 0.38	0.93

Test of significance is mann-whitney U-test, p-value <0.05 is statistically significant. Asterisk (*) means highly statistical significance.

Table 3
Changes in forced expiratory volume in first second.

	Preoperative FEV1%	Postoperative FEV1%	P-value
Group A (n = 68)	59.7 ± 15.43	61.2 ± 15.41	0.082
Group B (n = 64)	60.1 ± 15.4	64.2 ± 14.7	0.03

FEV1: Forced expiratory volume in first second, all values in mean ± SD, Test of significance is wilcoxon signed rank test.

Table 4
Frequency of use of paravertebral block drugs and supplementary drugs during the first three postoperative days.

POD	Group A (n = 68)	Group B (n = 64)	P-value
Frequency of paravertebral block drug use			
POD-0	3.51 ± 0.5	2.98 ± 0.46	0.001
POD-1	3.98 ± 0.9	2.59 ± 0.5	<0.001
POD-2	2.38 ± 0.8	1.7 ± 0.55	<0.001
POD-3	1.26 ± 0.9	1.2 ± 0.98	0.72
Frequency of supplementary drug use			
POD-0	1.27 ± 0.9	1.2 ± 0.9	0.64
POD-1	1.56 ± 0.6	0.75 ± 0.7	<0.001
POD-2	1.18 ± 0.77	0.62 ± 0.74	<0.001
POD-3	0.43 ± 0.66	0.5 ± 0.87	0.57

POD:postoperative day, All values in mean ± SD, Test of significance is student t-test.

Table 5 presented the postoperative complications in both groups, where atrial fibrillation (AF) and prolonged air leak were higher in group A (disrupted pleura) than that in group B, ($p = 0.19$, 0.5 respectively). Nausea & vomiting were significantly higher among patients in group A ($p = 0.02$).

4. Discussion

The use of this technique of PVB catheter insertion for control of postoperative pain was done to try a simple and effective technique for analgesia as well as to avoid the side effects of systemic opioids and even thoracic epidural blocks. As the thoracotomy incision is one sided, there is no need for extended block. This technique has minimal hemodynamic effects, maintains pulmonary functions and is devoid of systemic morphine side effects. Thoracic PVB with a catheter using Bupivacaine as a local anesthetic provides better postoperative analgesia than intravenous morphine as an analgesic agent in patients undergoing pulmonary surgery via a posterolateral thoracotomy incision [9].

4.1. Assessment of pain score

As regards the effect of paravertebral block on postoperative pain in both groups, we observed that paravertebral block produced significant decrease in VAS scores postoperatively in group B (with intact pleura) in the first 24 h as compared to group A (pleural disruption group). Patients in group B reported less pain than patients in group A at 1, 6, 12, and 24 h postoperatively.

Table 5
Postoperative complications in both groups.

	Group A (n = 68)	Group B (n = 64)	P-value
Atrial Fibrillation	4 (5.9)	1 (1.5)	0.19
Prolonged air-leak	5 (7.3)	3 (4.7)	0.5
Nausea & vomiting	12 (17.6)	3 (4.7)	0.02

All values in number & percentage, Test of significance is chi-square.

Regarding VAS pain scores in group B, our results were similar to that of Bilgin et al. who compared the effects of continuous PVB using Bupivacaine to intravenous metamizol as a systemic analgesic. They found that PVB decreased pain severity significantly than the systemic analgesic up to 72 h postoperatively [10].

Kairaluoma et al. found nearly the same results as those in our study when they compared pre-incisional PVB (single injection) with Bupivacaine to IV Oxycodone for relieving postoperative pain after breast surgery. PVB in their study reduced chronic pain symptoms up to 12 months postoperatively [11].

Also, our results regarding group B, were similar to that reported by Asida et al., who reported significant decrease in VAS Pain scores during the first postoperative 16 h when they used Bupivacaine 0.5% into the thoracic PVB catheter [9].

In group B (no pleural tear) we had similar results to that reported by Ibrahim et al. who reported significant decrease in VAS Pain scores during the first postoperative 72 h when they used Bupivacaine 0.5% into the thoracic PVB catheter to compare its safety and efficacy between two groups anterior thoracotomy and posterior thoracotomy [12].

4.2. Assessment of pulmonary functions

In our study we noticed an improvement in FEV1% in both groups from preoperative to postoperative values, but the improvement was statistically significant in group B (no pleural tear), and the increase in postoperative FEV1% was about 18.5%.

This was different from Esme et al., who reported postoperative decrease in FEV1% by about 6.25%, when they used Bupivacaine in PVB catheter on 15 patients [13].

Hill et al. showed that there was no significant difference between single-dose multi-level PVB and systemic analgesia using morphine as regards peri-operative pulmonary functions. They used forced vital capacity (FVC) and forced expiratory volume in first second (FEV1) as measurements of pulmonary functions [14].

The results of Bilgin et al. were against our results as they observed that there was a decrease in postoperative FEV1 values in both PVB and systemic analgesia group when compared to the preoperative values. On the first postoperative day when the mean FEV1 values were compared with the preoperative values, in group I (PVB), FEV1 was 38% and in group II (systemic analgesia), FEV1 was 55%of the preoperative values [10].

We think that these differences because they used the standard anesthetic technique of catheter insertion which was done by the anesthesiologist before induction of anesthesia when the patient is still awake. They used the loss of resistance technique which has higher incidence of pleural disruption, which in turn lowers the analgesic effect of local anesthetic injected into the catheter, and do not have positive impact on pulmonary functions.

4.3. Assessment of drug use (PVB Bupivacaine and supplementary drugs)

We noticed a statistically significant decrease in the frequency of PVB Bupivacaine use in group B than in disrupted pleura group (group A), during the first two postoperative days, (p-value = 0.001), and the need for analgesia decreased significantly throughout the days from postoperative day zero to three in both groups.

Also the frequency of supplementary drug use decreased significantly in POD-1 and POD-2, in both groups, but the decrease was more significantly different in group B than in the disrupted pleura group.

Our results were similar to that reported by Komatsu et al., where they observed a significant decrease in supplementary drug use between intact and disrupted pleura group in the favor of intact pleura group, but they used NSAIDS not more than four times per day as supplementary drug and we used paracetamol infusion not more than three times per day [15].

Also Esme et al., used paracetamol 1 gm infusion as a supplementary drug where 26% (4/15) of patients in the Bupivacaine group needed supplementary drugs during the first three postoperative days [13].

The need for rescue drugs during the first three postoperative days in disrupted pleura group (group A) was significantly higher than in intact pleura group (group B). We had 23.5% (16/68) in group A versus 9.4% (6/64) in group B who needed rescue medications in the form of (meperidine 50 mg) in a dose of 0.5–1 mg/kg, subcutaneous or intravenous injection maximally twice per day. This was similar to Komatsu et al. [15], where they had 26.9% (21/78) of patients in pleural tear group who needed rescue drug, versus 14.1% (11/78) in intact pleura group. But in contrast to our study, they used intramuscular pentazocin as rescue medication.

In our study, the incidence of analgesic failure with paracetamol infusion as well as the frequency of paracetamol infusion use on POD-1, 2 among the patients with pleural disruption was significantly higher than those without. This finding should well support the hypothesis that the disrupted pleura cannot contain the infused LA sub-pleurally, which is likely to diminish the analgesic effectiveness.

4.4. Assessment of complications

The PVB catheter creates a very limited extrapleural space, that could accommodate little amounts of local anesthesia (LA). An extra amount of the LA was supposed to leak from that sub-pleural space if the pleural membrane is injured, while pleural tenting will occur if the pleura remains intact. We stopped the LA and removed the PVB catheter when postoperative chest tubes were removed. Almost all of the patients received two to three days of PVB. The LA leaking from the sub-pleural space was drained through a chest tube. Therefore, there could be a remote possibility of LA toxicity.

The dose of Bupivacaine (20 ml 0.5%) which was used in our study was similar to several studies such as Andre and colleagues who used the same dose in a catheter for breast surgery [16]. Also, Richardson and colleagues used the same dose in a large study [17].

Postoperative atrial fibrillation (AF) was noticed more in group A (pleural disruption), where there was 5.9% (4/68) of patients and in intact pleura group there was 1.5% (1/64) of patients having AF. This was near from results reported by Komatsu et al. who reported 3.9% (3/78) of patients in the pleural tear group having AF, and only one case 1.3% (1/78) of intact pleura group having AF [15].

Regarding drug pharmacokinetics, Burlacu et al. [18] found that, after paravertebral administration of LA, the maximum plasma concentration of the medications was within the safe range or was less than that of the effective levels after intravenous administration.

Karmakar et al. [19] reported that infusion of radioopaque contrast medium in the sub-pleural space remained in the paravertebral space. This finding strongly suggests that the analgesic effect induced by PVB can be greatly referred to a peripheral mechanism of action.

Regarding nausea and vomiting, we observed a statistical significant difference between both our groups where in group A (pleural disruption) we had 17.6% (12/68) of patients, and in group B (without pleural disruption), there was 4.7% (3/64) of patients who developed nausea and vomiting. Our results were similar to that reported by Komatsu et al., [15] who found that 19.2% (15/78) of patients in pleural tear group developed nausea and vomiting, while in intact pleura group only 1.3% (1/78) of patients had nausea and vomiting.

Fagenholz et al. [20] also advocated the importance of intact pleura when considering the adverse effects of PVB. These authors stated that, once the LA enters the pleural space through the pleural tears, the absorption of the LA from the pleural space is more rapid compared with that from the paravertebral space; this, in turn, might result in systemic toxicity, causing nausea and convulsions. Our study showed the higher incidence of postoperative nausea/vomiting in patients with pleural disruption ($P < 0.02$), which could be well understood by the report of Fagenholz et al. [20]; further, the total incidence of nausea was much lower compared with that reported for that happened with epidural block.

The main limitation of this study was the subjective nature of pain, which was difficult to measure precisely.

5. Conclusion

The use of thoracic PVB catheter is safe, and effective in post-thoracotomy pain control especially with preservation of the integrity of parietal pleura without disruption, through careful and meticulous paravertebral block catheter insertion. Also additional research should be applied in a prospective study to compare the intraoperative Seldinger technique to the classic surgical technique of catheter insertion.

Conflict of interest

No conflicts of interest.

References

[1] Takamori S, Yoshida S, Hayashi A, Matsuo T, Mitsuoka M, Shirouzu K. Intraoperative intercostal nerve blockade for postthoracotomy pain. Ann Thorac Surg 2002;74:338−41.
[2] Messina M, Boroli F, Landoni G, Bignami E, Dedola E, N'zepa Batonga J, et al. A comparison of epidural vs paravertebral blockade in thoracic surgery. Minerva Anesthiol 2009;75:616−21.
[3] Sabanathan S, Richardson J, Shah R. Continuous intercostal nerve block for pain relief after thoracotomy. Updated in 1995. Ann Thorac Surg 1988;1995(59):1261−3.
[4] Scarci M, Joshi A, Attia R. In patients undergoing thoracic surgery is paravertebral block as effective as epidural analgesia for pain management? Interact Cardiovasc Thorac Surg 2010;10:92−6.
[5] Gulbahar G, Kocer B, Muratli SN, Yildirim E, Gulbahar O, Dural K, et al. A comparison of epidural and paravertebral catheterisation techniques in post-thoracotomy pain management. Eur J Cardiothorac Surg 2010;37:467−72.
[6] Raveglia F, Rizzi A, Leporati A, Di Mauro P, Cioffi U, Baisi A. Analgesia in patients undergoing thoracotomy: epidural versus paravertebral technique. A randomized, double-blind, prospective study. J Thorac Cardiovasc Surg 2014;147:469−73.
[7] Komatsu T, Sowa T, Takahashi K, Fujinaga T. Paravertebral block as a promising analgesic modality for managing post-thoracotomy pain. Ann Thorac Cardiovasc Surg 2014;20:113−6.
[8] Elsayed H. Insertion of paravertebral block catheters intraoperatively to reduce incidence of block failure. Interact Cardiovasc Thorac Surg 2012;14:648−9.
[9] Asida SM, Youssef IA, Mohamad AK, Abdelrazik AN. Post-thoracotomy pain relief: thoracic paravertebral block compared with systemic opioids. Egypt J Anaesth 2012;28:55−60.
[10] Bilgin M, Akcali Y, Oguzkaya F. Extrapleural regional versus systemic analgesia for relieving post-thoracotomy pain: a clinical study of bupivacaine compared with metamizol. J Thorac Cardiovasc Surg 2003;126:1580−3.
[11] Kairaluoma PM, Bachmann MS, Rosenberg PH, Pere PJ. Preincisional paravertebral block reduces the prevalence of chronic pain after breast surgery. Anesth Analg 2006;103:703−8.
[12] Ibrahim BM, Abd Alkawei A. Pain control after thoracotomy; paravertebral block by bupivacaine. J Egypt Soc Cardiothorac Surg 2012;20(1−2):185−9.
[13] Esme H, Apiliogullaria B, Durana FN, Yoldasa B, Bekcib TT. Comparison between intermittent intravenous analgesia and intermittent paravertebral subpleural analgesia for pain relief after thoracotomy. Eur J Cardiothorac Surg 2012;41:10−3.
[14] Hill SE, Keller RA, Stafford-Smith M, Grichnik K, White WD, D'Amico TA, et al. Efficacy of single-dose, multilevel paravertebral nerve blockade for analgesia after thoracoscopic procedures. Anesthesiology 2006;104:1047−53.
[15] Komatsua T, Sowa T, Kinob A, Fujinaga T. The importance of pleural integrity for effective and safe thoracic paravertebral block: a retrospective comparative study on postoperative pain control by paravertebral block. Interact Cardiovasc Thorac Surg 2015;20:296−9.
[16] Andre P, Med M, Robert M. Continuous thoracic paravertebral block for major breast surgery. Region Anesth Pain Med 2006;31(5):470−6.
[17] Richardson J, Sabanathan S, Jones J, Sah RD, Cheema S, Mearns AJ. A prospective, randomized comparison of preoperative and continuous balanced epidural or paravertebral bupivacaine on post-thoracotomy pain, pulmonary function and stress responses. Br J Anaesth 1999;83:387−92.
[18] Burlacu CL, Frizelle HP, Moriarty DC, Buggy DJ. Pharmacokinetics of levobupivacaine, fentanyl, and clonidine after administration in thoracic paravertebral analgesia. Reg Anesth Pain Med 2007;32:136−45.
[19] Karmakar MK, Kwok WH, Kew J. Thoracic paravertebral block: radiological evidence of contralateral spread anterior to the vertebral bodies. Br J Anaesth 2000;84:263−5.
[20] Fagenholz PJ, Bowler GM, Carnochan FM, Walker WS. Systemic local anaesthetic toxicity from continuous thoracic paravertebral block. Br J Anaesth 2012;109:260−2.